DETAILED ACTION

Status of Claims

1. The amendment filed 07/27/2009 has been entered. Claims 1-3, 6-14, and 19-22 remain pending. Claims 20-22 are new.

2. The previous 35 USC 102(b) rejection of claims 1-3 as being anticipated by Smiljanic *et al.* (*Chem. Phys. Lett.,* 356, 2002, 189-193) is withdrawn in light of Applicant's amendment to claim 1. Smiljanic does not disclose a DC thermal plasma torch.

3. All pervious 35 USC 103(a) rejections of claims 6-14 and 19 have been withdrawn because all directly or indirectly dependent on now amended claim 1. The primary reference used was Smiljanic *et al.* (see above).

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The term "fast" in claim 1 is a relative term which renders the claim indefinite. The term "fast" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. It is not known has "fast" the fast quenching nozzle quenches the metal vapor. A rate would overcome this rejection.

6. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

7. Claim 20 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Applicant submits support for newly added claim 20 can be found in the specification at p. 4, lines 12-17. Examiner respectfully submits support for newly added claims 22 was not found therein.

New Art Rejection

Claim Rejections - 35 USC § 103

8. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

9. Claims 1-3, 6-7, 11-12 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smiljanic *et al.* (*Chem. Phys. Lett.*, 356, 2002, 189-193) in view of Tsantrizos *et al.* (5,395,496), hereafter Tsantrizos #1, and Matsumoto *et al.* (JP 07061803).

Regarding claim 1, Smiljanic teaches a process for synthesizing single wall carbon nanotubes (SWNT) comprising:

- SWNT (abstract);
- injecting a carbon containing substance (e.g. ethylene) (abstract);

- in situ generated nanometer sized metal catalyst particles that act as nucleation points for the growth of SWNT (p. 190, col. 2, lines 4-5);
- producing SWNT (p. 109, Fig. 1); and
- collecting SWNT on a plate (p. 109, Fig. 1).

Smiljanic does not teach injecting a carbon-containing substance via a fast quenching nozzle attached to a high enthalpy electrode-generated direct current thermal plasma.

Tsantrizos #1 teaches a process for synthesizing carbon nanostructures (fullerenes) by injecting a carbon-containing substance via a fast quenching nozzle attached to a high enthalpy electrode-generated direct current thermal plasma (abstract, Fig. 1).

It would have been obvious to one of ordinary skill in the art at the time of invention to use a DC thermal plasma torch to make both fullerenes and SWNT motivated by Matsumoto.

Matsumoto teaches the synthesis of both fullerenes and carbon nanotubes using a high-frequency plasma (abstract), equivalent to a thermal plasma torch. One skilled in the art would have been motivated to make carbon nanotubes due to their unique electronic and physical properties.

Regarding claims 2 and 3, Smiljanic teaches the carbon containing substance is injected together with a carrier gas (Fig. 1). The carrier gas is argon (Fig. 1).

Regarding claim 7, Smiljanic teaches metal vapor in the plasma which nucleates into nanoparticles in the zone of nanostructure formation (Experimental section, Fig. 1).

Regarding claim 11 and 12, Smiljanic teaches, as described in the experimental section, the carbon-containing gas and catalyst are introduced together and each controlled independently

(page 190, col. 2). The ferrocene vapor is obtained by a temperature-controlled sublimation and the carbon-containing gas controlled separately within the specified flow ranges.

Regarding claim 6 and 22, Tsantrizos #1 teaches tetrachloroethylene vaporized before injection (col. 4, lines 41-45).

10. Claims 8-10 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smiljanic, Tsantrizos #1, and Matsumoto as applied to claims 1 and 7 above, and further in view of Tsantrizos *et al.* (5,147,998), hereafter Tsantrizos #2).

Regarding claims 8-10, Smiljanic, Tsantrizos #1, and Matsumoto are silent as the electrode material of construction.

Tsantrizos #2 teaches the same high enthalpy plasma torch as applicant and Tsantrizos #1. The electrode may be tungsten (col. 3, lines 44-50).

It would have been obvious to one of ordinary skill in the art at the time of invention to use tungsten motivated by the fact that tungsten is a suitable refractory material for electrode construction (col. 3, lines 44-54) due to tungsten's high boiling point.

Regarding claim 19, Smiljanic, Tsantrizos #1, and Matsumoto do not teach a cooling system.

Tsantrizos #2 teaches a cooling system (col. 2, lines 46-52).

It would have been obvious to one of ordinary skill in the art at the time of invention to use a cooling system to keep the system from overheating and melting the electrodes (col. 4, lines 23-43).

11. Claims 13-14 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smiljanic, Tsantrizos #1, and Matsumoto as applied to claim 1 above, and further in view of Cohen *et al.* (5,993,697).

Regarding claims 13 and 14, Smiljanic, Tsantrizos #1, and Matsumoto do not teach the catalyst is derived from at least one metal powder injected into the outlet flame of the torch. Cohen, directed towards making carbon materials, teaches the use of a plasma arc and catalytic particles in powder or other forms and injected directly into the arc (col. 14, lines 12-15). It would have been obvious to one of ordinary skill in the art at the time of invention to use a metal powder catalyst to produce metallic carbon useful in optical devices (col. 14, lines 43-47).

Regarding claim 21, Cohen teaches the metal catalysts are selected from transition metals (col. 14, lines 12-15).

12. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Smiljanic, Tsantrizos #1, Matsumoto, and Cohen as applied to claim 13 above, and further in view of Geobegan *et al.* (2002/0179564).

Regarding claims 20, Smiljanic, Tsantrizos #1, Matsumoto, and Cohen do nor teach metal catalyst particles are melted, vaporized in part, and sprayed onto a substrate, and the sprayed catalyst particles act as nucleation points for the growth of carbon nanotubes thereon.

Geobegan, directed towards synthesizing carbon nanotubes, teaches normal plasma spray involves powder-feeding a plasma torch to melt micron-sized particles and direct them at high-velocity toward a substrate. Molten particles are accelerated to the substrate where they impact, splat, and cool very rapidly (para 0094).

It would have been obvious to one of ordinary skill in the art at the time of invention spray the catalyst on the substrate as recited for high volume carbon nanotube growth (para 0094).

Response to Arguments

13. Applicant's arguments with respect to claims 1-3, 6-14, and 19 have been considered but are moot in view of the new ground(s) of rejection.

14. Regarding the election of species, arguments are not moot since Applicant has canceled claims 15 through 18. As such, the restriction is made final. Paragraph 7 of the Office Action dated 10/28/2009 was included in error and does not apply since there are only process claims.

15. A new art rejection was made necessitated by Applicant's amendment of claim 1. The new cited art as combined teaches a heterogeneous reaction process and evidence to support both fullerenes and carbon nanotubes can be produced from a high enthalpy torch with metal catalyst precursors introduced as recited and would be obvious to do so as presented in this Office Action.

16. Applicant argues the present process requires the use of strong quenching rates. In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., fast quenching rates) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

17. Applicant argues a region of nanoparticle loading around a specific temperature for metal- nanotube segregation. In response to applicant's argument that the references fail to show

certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., the specific temperature) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

18. Regarding the material of construction of the electrode, Examiner respectfully submits that Tsantrizos #1 and #2 meet the claims limitation as recited.

19. Applicant argues that the catalyst needs to be in a specific morphology and the correct diameter, not achievable by the Smiljanic process. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). These limitations are shown with the combination of Tsantrizos #1 and Matsumoto. Furthermore, in response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., the catalyst particle size) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Conclusion

20. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Carlos Barcena whose telephone number is (571) 270-5780. The examiner can normally be reached on Monday through Thursday 8AM - 5PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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